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A REVIEW OF THE SYNENTOGNATHOUS FISHES OF JAPAN.

BY

DAVID STARR JORDAN

AND

EDWIN CHAPIN STARKS,

Of the Leland Stanford Junior University.

From the Proceedings of the United States National Museum, Vol. XXVI, pages 525-544.

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A REVIEW OF THE SYNENTOGNATHOUS FISHES OF JAPAN.

By David Starr Jordan and Edwin Chapin Starks,

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In this paper is given an account of those fishes of Japan belonging to the suborder of *Synentognathi*. The material examined belongs to the United States National Museum and to the Leland Stanford Junior University, most of it having been collected by Messrs. Jordan and Snyder during the summer of 1900.

Suborder SYNENTOGNATHI.

Lower pharyngeal bones fully united; second and third superior pharyngeals variously enlarged, not articulated to the cranium, sending processes forward; the fourth small or fused with the third. Vertebræ numerous (45 to 70), the abdominal ones much more numerous than the caudal. Ventral fins abdominal, without spine, the rays more than five. Scapula suspended to the cranium by a post-temporal bone, which is usually simple, furcate in *Belonidæ*. Articular bone of lower jaw with a small supplemental bone perhaps corresponding to the coronoid bone. Parietal bones usually absent, when present much reduced, well separated by the supraoccipital. Supraclavicle small when present; no interclavicles. No mesocoracoid. Maxillary very close to premaxillary and sometimes firmly joined to it, the suture always distinct. Basis of cranium double in front, but without muscular tube. No adipose fin. Fins without spines. Lateral line concurrent with the belly, peculiar in structure. Air bladder usually large, without pneumatic duct. Intestinal tract simple, without pyloric cæca. This order is allied to the Haplomi on the one hand and to the Percesoces on the other, and, like these groups, it marks the transition from the soft-rayed to the spiny-rayed fishes. In their anatomical characters the *Synentognathi* most resemble the latter, but there are never spines in the fins, and the lower pharyngeals are united. The group is divisible into four closely related families, which have usually been regarded as divisions of one

family, *Exocœtidæ* or *Scombresocidæ*. The remarkable differences in the pharyngeals seem to us to permit the division of the group into four families.

(σύν, together; ἔν, within; γνάθος, jaw.)

a. Third superior pharyngeal on each side scarcely enlarged, not longer than its anterior process, and armed with comparatively few (about 15) pointed teeth; fourth superior pharyngeal distinct on each side; lower pharyngeals united into a small linear plate, armed with small teeth; vertebræ with zygapophyses; both jaws produced in a long beak in the adult (the upper short in the young); teeth in jaws strong, unequal; maxillaries firmly appressed to the premaxillaries; a distinct suture along the boundary; "coronoid" bone (attached to the articular) evident. Species carnivorous ..... BELONIDÆ, 1.

aa. Third superior pharyngeal greatly enlarged, covered with bluntish, tricuspid teeth; fourth superior pharyngeal wanting or fused with the third; lower pharyngeals large, fused into a thick triangular bone with transversely concave surface, covered with blunt, tricuspid teeth; teeth in jaws always small, conic, or tricuspid; maxillary close to premaxillary, but not suturally joined to it, there being some open space between; coronoid bone small, but present; no canine teeth; no zygapophyses to the vertebræ.

b. Third superior pharyngeal solidly joined with its fellow to form an ovoid plate, which sends two processes forward; cleft of mouth narrow; the lower jaw usually produced; teeth of jaws tricuspid; herbivorous species. HEMIRAMPHIDÆ, 2.

bb. Third superior pharyngeals more or less closely appressed, but not united; species at least partly carnivorous.

c. Dorsal and anal fins each with several detached finlets; cleft of mouth long, both jaws being more or less produced in a pointed beak; paired fins small. SCOMBRESOCIDÆ, 3.

cc. Dorsal and anal without finlets; cleft of mouth short, the jaws not produced in a beak; pectoral fins more or less produced, forming an organ of flight. EXOCŒTIDÆ, 4.

Family 1. BELONIDÆ.

NEEDLE-FISHES.

Body elongate, very slender, compressed or not, covered with small, thin scales. Lateral line very low, running as a fold along side of belly. Both jaws produced in a beak, the lower jaw the longer, very much the longer in the young, which resemble *Hemiramphus;* maxillaries grown fast to premaxillaries; each jaw with a band of small, sharp teeth, besides a series of longer, wide-set, sharp, conical teeth. No finlets. Dorsal fin opposite anal, both fins rather long. Air bladder present. Lower pharyngeals united to form a long, slender, narrow plate, with flat surface, covered with small, pointed teeth; upper pharyngeals distinct, the third pair little enlarged, each with some 15 moderate, unequal, pointed teeth (*Tylosurus marinus*); fourth pair well developed, with similar teeth, but without anterior processes. Vertebræ numerous, with zygopophyses. Ovary single. Voracious, carnivorous fishes, bearing a superficial resemblance to the gar pikes;

found in all warm seas, sometimes entering rivers. Their habits are ordinarily much like those of the pike, but when startled they swim along the surface with extraordinary rapidity, often leaping above the water for short distances. When thus leaping the large species of the tropics are sources of danger to incautious fishermen, sometimes piercing the naked abdomen of the natives. Most of them are good food-fishes, but the green color of the bones of the larger species often causes them to be avoided, for no good reason.

a. Gill rakers wanting; no teeth on vomer; anterior rays of dorsal and anal elevated. *Tylosurus*, 1.

1. TYLOSURUS Cocco.

Tylosurus Cocco, "Lettere in Giornale Sci. Sicilia, XVII," 1829, p. 18 (*cantraini=imperialis*).

Body elongate, very slender, not much compressed. Both jaws prolonged into a beak, the lower jaw somewhat the longer, much the longer in young fishes, the very young resembling *Hemiramphus*. Each jaw armed with a band of small, sharp teeth, beside which is a series of longer, wide-set, sharp, conical, unequal teeth; no teeth on vomer or palatines. Scales small, thin; lateral line running along the side of the belly, becoming median on the tail. No finlets. Dorsal fin more or less elevated anteriorly; caudal fin short, unequally lunated or forked; pectorals moderate; ventrals small, the latter inserted behind the middle of the body. Gill rakers obsolete. Bones usually more or less green. Size comparatively large. Species numerous. Voracious fishes, chiefly American; one species crossing to Europe; some of them entering rivers. This genus differs from the Old World genus, *Belone* Cuvier, in the absence of gill rakers and of vomerine teeth.

(τύλος, callus; οὐρά, tail; in allusion to the caudal keel, on which the genus was originally based, a character of little importance.)

a. Dorsal rays about 25.

b. Lateral line not forming a black keel on caudal peduncle. Posterior dorsal rays produced to form a rounded lobe as high or nearly as high as produced anterior lobe, these rays longest in the young. Jaws slender and long; upper jaw from anterior orbital rim 2½ times longer than length of rest of head. *schismatorhynchus*, 1.

bb. Lateral line extending on caudal peduncle, forming a low black keel.

c. Jaws short and stout; upper jaw from anterior orbital rim 1⅔ longer than rest of head; posterior rays of dorsal elevated; size very large ..... *giganteus*, 2.

cc. Jaws slender and long; posterior rays of dorsal short; body scarcely compressed ..... *coromandelicus*, 3.

aa. Dorsal rays about 18; posterior rays of dorsal short. Body much compressed, the width one-half the depth; caudal peduncle much compressed, without keel ..... *anastomella*, 4.

1. TYLOSURUS SCHISMATORHYNCHUS (Bleeker).

DATSU.

Belone gracilis SCHLEGEL, Fauna Japonica, Poiss., 1846, p. 246, pl. cx, fig. 1; Nagasaki; not of Lowe, 1839, a species from Madeira.—BLEEKER, Nieuwe Nalez., Japan, 1857, p. 116.—NYSTROM, Svensk. Vet. Akad. Handl., 1887, p. 44; Nagasaki.

Mastacembelus gracilis BLEEKER, Ned. Tyds. Dierk., 1866, p. 111.

Belone schismatorhynchus BLEEKER, Nat. Tydschr. Ned. Ind., I, 1850, p. 95.—BLEEKER, Verh. Gen., XXIV, 1866, p. 15.—GÜNTHER, Cat. Fish, VI, 1866, p. 239; Mozambique, Zanzibar.—ISHIKAWA, Prel. Cat., 1897, p. 18; Boshu.

Mastacembelus schismatorhynchus BLEEKER, Atlas Ichth. Ind. Belon., about 1870, p. 49; Java, Ternate, Nagasaki.

Head from tip of upper jaw $4\frac{1}{4}$ to $4\frac{1}{2}$ in length; depth equals postorbital part of head; dorsal 24 to 27; anal 25 to 27.

Body very elongate and rather strongly compressed, the sides vertical and parallel. Dorsal and anal outlines parallel from head to dorsal. Jaws very slender and long; upper jaw from anterior orbital rim $2\frac{1}{2}$ times longer than rest of head. Premaxillary toward base constricted slightly and strengthened above by a mass of bone along the posterior fourth of the length, which ends in a point as viewed from above. Diameter of eye equals interorbital width and is contained 2 to $2\frac{1}{8}$ in postorbital part of head. Top of head from above eyes to occiput smooth with a translucent cartilage-like tissue. Nostril an elongate, somewhat triangular pit containing a simple undivided papilla. Head apparently naked except a patch of scales above cheeks and another on top of head from eyes to base of mixillary.

Pectoral equal to postorbital part of head or sometimes slightly longer. Ventrals inserted nearer the anterior margin of the eye than the base of the caudal by a distance equal to a diameter of the eye, their length twice the diameter of the eye. Anal placed well in advance of dorsal; the base of the sixth ray under the base of the first dorsal ray, the anterior part of anal strongly concave on its posterior margin. Distance of base of last anal ray from base of auxiliary caudal rays $1\frac{1}{4}$ to $1\frac{1}{6}$ times the diameter of the eye; the last ray reaches a little over half this distance. Distance from front of anal to base of ventrals is contained 5 times in length from middle of eye to caudal base; the anal base exceeds this length by $1\frac{1}{2}$ times the diameter of the eye. Dorsal scarcely so strongly concave behind the anterior rays as anal; its longest rays are behind the middle. When fin is depressed the tip of eighth ray from the last reaches base of last ray. Distance between base of last dorsal ray and base of auxillary caudal rays equals diameter of eye; the depressed dorsal reaches five-sixths of this distance. Median caudal rays about half the length of longest rays of lower caudal lobe, which is a little longer than the upper. The lateral line is not at all produced as a keel on caudal peduncle.

Color in spirits: A bluish diffused lateral band follows the contour of back, running from the pectoral base to just above the middle of the caudal base, growing narrower posteriorly. Above lateral band the body is greenish or brownish; below uniformly bright silvery. Upper part of head dark, except translucent cartilaginous area; base of upper jaw black; head otherwise silvery. Distal half of pectoral black; outer rays and tips of ventrals dusky; anterior rays of anal dusky toward tips; dorsal blackish, except bases of anterior rays, the rays usually green; caudal dusky.

Here described from specimens from Nagasaki 45 cm. in length. Other specimens are from Wakanoura.

(σχίσμα, split; ῥύγχος, snout.)

2. TYLOSURUS GIGANTEUS (Schlegel).

OKIZAYORI (OFFSHORE NEEDLEFISH).

?Belone indica LE SUEUR, Journ. Ac. Nat. Sci. Phila., II, 1821, p. 131; India.

Belone gigantea SCHLEGEL, Fauna Japonica, Poiss., 1846, p. 245; Nagasaki.—BLEEKER, Ac. Soc. Indo-Nederl., III, Japan, p. 21.

Belone annulata CUVIER and VALENCIENNES, Hist. Nat. Poiss., XVIII, 1846, p. 447; Celebes, Friendly Islands, Seychelles, Pondicherry.

Belone annulata GÜNTHER, Cat. Fish., VI, 1866, p. 240; Pinang, China.—ISHIKAWA, Prel. Cat., 1897, p. 18; Tokyo, Formosa.

Mastacembelus annulatus BLEEKER, Atlas Ichth. Belon., 1870, p. 48; Java, Madura, Bawean, Cocos, Sumatra, Singapore, Celebes, Pinang, Batjan, Ternate, Amboina, Gilolo.

?Belone melanurus BLEEKER, Verh. Bat. Gen., XXII, 1849, p. 11.

Belone cylindrica BLEEKER, Verh. Bat. Gen., XXIV, 1851, p. 13.

?Belone brachyrhynchus BLEEKER, Nat. Tyds. Ned. Ind., VI, 1854, p. 61; Gilolo, young.

Head from tip of lower jaw $3\frac{3}{8}$ in length; depth at ventrals $1\frac{1}{8}$ in postorbital part of head. Dorsal 23; anal 21.

Body as wide as deep to within a short distance of dorsal, the interorbital space and head above gently convex. Jaws rather short and stout, the lower slightly the longer; their sides nowhere parallel but approaching rather rapidly to a point. Length of snout from anterior margin of eye equal to the distance from same point to middle of longest pectoral rays. Eye one-third of postorbital part of head, one-half of interorbital. Interorbital space with two low ridges, separated from each other by a space equal to two-thirds diameter of eye, impreceptibly diverging anteriorly. Between them are two narrower, shorter, parallel ridges separated by a space one-third of diameter of eye. Nostrils broad, triangular, containing a fleshy process divided into many folds. Cheeks entirely scaled; scales on top of head before eyes to base of premaxillary.

Length of pectoral equals postorbital part of head and one-third eye. Length of ventrals contained $2\frac{1}{4}$ times in space between their base and front of anal. Insertion of ventrals midway between middle

of eye and base of caudal. Front of anal directly under front of dorsal, its base shorter than that of dorsal by three-fourths diameter of eye, and equal to the distance between ventrals and anal. Outline of dorsal and anal deeply concave behind anterior rays. Anterior rays of the latter longer than those of dorsal. Base of the last anal ray distant from base of auxilliary caudal rays twice the distance from last dorsal ray to the corresponding caudal ray. Anterior dorsal rays longer than the long posterior dorsal rays. When dorsal is depressed the seventh from the last ray reaches to the base of the last ray and the tips of the last few rays barely reach the base of the auxiliary caudal rays. Caudal evidently forked, the lower lobe the longer. Lateral line strongly produced on caudal peduncle forming a keel.

Silvery on sides and lower parts growing rather gradually greenish on back. Top of head and upper jaw black. A long black blotch at edge of preopercle. Dentate margin of lower jaw black; head otherwise silvery. Inner face and posterior part of outer face dusky. Ventrals dark except inner rays. Anterior ray of anal dusky. Dorsal and caudal blackish. Lateral line on caudal peduncle black.

Here described from a single specimen from Nagasaki, 33 inches in length.

A young specimen of this or some closely related species from Wakanoura differs in having the posterior rays of the dorsal lengthened to well beyond the base of caudal (when the dorsal is depressed), the caudal scarcely forked and with a black blotch at its base, the eye, of course, much larger and the general color much darker and without silvery pigment. It is but 12 cm. in length.

According to Bleeker the type of *giganteus* examined by him in the Leyden Museum is identical with *annulatus*. The name *giganteus* is apparently the earlier of the two, but *indicus*, about the pertinence of which there is some doubt, is earlier than either. A species apparently identical with these occurs in Hawaii and in Samoa.

3. TYLOSURUS COROMANDELICUS (Van Hasselt).

Belone coromandelicus VAN HASSELT, Alg. Konst., 1823, p. 130; Coromandel, according to Bleeker.

Belone timucoides DE FERUSSAC, Zool., 1823, p. 372, after Van Hasselt.

Belone melanotus BLEEKER, Nat. Tyds. Ned. Ind., I, 1850, p. 94.—BLEEKER, Verh. Genootsch., XXIV, 1851, p. 14.—GÜNTHER, Cat. Fish., VI, 1866, p. 239; East Indies.

Mastacembelus melanotus BLEEKER, Atlas Ichth. Ind. Belon., 1870, p. 47; Java, Singapore, Molucca, Celebes.

Head 3½ in length; depth exceeds postorbital part of head by one-fourth eye. Dorsal 25 or 26; anal 23 or 24.

Body scarcely compressed. Head nearly flat between eyes. Jaws rather slender and long. Snout from anterior margin of eye equal to twice the distance from same point to edge of opercle. Eye one-half

postorbital part of head, five-sixths of interorbital width. Interorbital rough, with longitudinal striations; a shallow groove along its middle.

Length of pectoral equals depth at ventrals, or $2\frac{2}{3}$ in dorsal base. Length of ventrals contained $2\frac{3}{4}$ times in space between their base and front of anal. Ventrals inserted midway between caudal base and posterior third of eye. Anal a little in advance of front of dorsal, its base shorter than that of dorsal by the diameter of eye. Outline of dorsal and anal deeply concave behind anterior rays. Anterior rays of dorsal equal in length to those of anal. Base of last anal ray twice the diameter of eye distant from base of auxiliary caudal rays. Last dorsal ray three-fourths eye from auxiliary caudal rays. Posterior dorsal rays not much elongated; the longest scarcely as long as eye; the third ray from the last reaches base of last ray in reclined fin; the last ray reaches three-fifths the distance between its base and base of auxiliary caudal rays. Caudal not deeply forked, the lower lobe much the longer. Lateral line on caudal peduncle slightly raised to a keel which is black.

Color in spirits: Greenish on back, silvery below; jaws and teeth green; pectoral dusky toward tips of rays; axil black; tips of front dorsal rays dusky, and dorsal black behind; tip of middle anal rays black; dorsal dusky.

Here described from a specimen 78 cm. in length from Tsuruga. Another specimen is in the collection from Yokohama.

There is no other record of the species from Japan. It is apparently frequently taken in the East Indies.

(*Coromandelicus*, from Coromandel.)

4. TYLOSURUS ANASTOMELLA (Cuvier and Valenciennes).

DATSU.

Belone anastomella CUVIER and VALENCIENNES, Hist. Poiss., XVIII, 1846, p. 446; China.—GÜNTHER, Cat. Fish., VI, 1866, p. 249; Shanghai, Japan, India.—ISHIKAWA, Prel. Cat., 1897, p. 18; Tokyo.—STEINDACHNER and DÖDERLEIN, Fische Japans, IV, 1887, p. 37; Tokyo.

Tylosurus anastomella JORDAN and SNYDER, Check List Fishes, Japan, 1901, p. 61; Yokohama.

Belonia ciconia RICHARDSON, Ichth. China, 1846, p. 264; Canton, on a drawing by Reeves.

Depth at ventral fins $1\frac{1}{7}$ in postorbital part of head, which is $9\frac{1}{3}$ in length from opercle to base of caudal. Dorsal, 18; anal, 23.

Body compressed, the width a little less than half depth. Tips of jaws broken in all our specimens; upper jaw to eye at least $3\frac{1}{5}$ from same point to base of caudal. Eye $3\frac{1}{5}$ in postorbital part of head, seven-eighths of interorbital width. Interorbital with a wide, shallow channel along its middle. Base of upper jaw not strengthened by a bony ridge, but outline of head evenly and slightly concave from

occiput to tip of jaw. Nostril as broad as deep, triangular. Suborbital space equal to depth of eye. Teeth rather slender; no teeth on palate.

Length of pectoral $1\frac{1}{4}$ in postorbital part of head. Ventrals inserted midway between base of pectoral and base of caudal, their length two-thirds that of pectoral. Base of eighth anal ray under first dorsal ray. Base of anal slightly less than space between its first ray and ventrals. Anterior anal rays longer than those of dorsal, or $1\frac{3}{5}$ in postorbital part of head. Base of last anal ray one-half diameter of eye anterior to base of last dorsal ray. Space between last anal ray and auxiliary caudal rays equal to length of anterior anal rays. Base of dorsal $1\frac{1}{4}$ in that of anal. Lower rays of caudal scarcely longer than upper rays; the caudal scarcely forked, lunate when fin is extended. Caudal peduncle compressed, without keel.

Color in spirits: A narrow bluish silvery lateral band, following outline of back, runs from above pectoral to caudal base; above the back is abruptly brownish; below the sides and belly are uniformly bright silvery; top of head dark; a dark band along posterior upper part of preopercle; tip of pectoral dusky; axil colorless; dorsal and caudal dark.

Here described from a specimen 70 cm. in length from Yokohama. Other specimens are from Tokyo, Matsushima, and Hakodate. It is not certain that the name *anastomella* is prior to *ciconia*, but the description is better.

(ἀναστόμος, sharp mouthed.)

Family II. HEMIRAMPHIDÆ.

HALF-BEAKS.

Body elongate, more or less compressed, covered with large cycloid scales; upper jaw short, lower jaw various, sometimes much produced, the toothed portion at base fitting against the toothed premaxillaries; teeth equal, mostly small and tricuspid; maxillaries anchylosed to premaxillaries. Gill rakers long. Caudal fin rounded, or forked; if forked, the lower lobe the longer. Anal fin modified in the viviparous species (*Zenarchopterus*), unmodified in the others and usually similar to the dorsal; no finlets; air bladder large, sometimes cellular. Third upper pharyngeal on each side much enlarged, solidly united with its fellow to form an oval plate, with slightly convex surface and covered with blunt tricuspid teeth; this is about as large as the united lower pharyngeals, and fits into the concavity of the latter; fourth upper pharyngeal wanting or grown fast to the third; lower pharyngeal large, thick, triangular, with concave surface. Vertebræ about 50.

Herbivorous fishes of the warm seas; mostly shore species; a few pelagic, a few confined to fresh water. They feed chiefly on green algæ, and, like the related forms, swim at the surface, occasionally

leaping into the air. Size rather small, rarely exceeding a foot in length. The species are closely related to the flying fishes, and the two families apparently closely intergrade.

a. Lower jaw acute, longer than upper, or more or less produced; teeth small; species oviparous, the anal fin in the male not modified, the caudal fin unequally lunate.
b. Lower jaw produced in a long, pointed beak, usually longer than rest of head. Body moderately compressed; pectorals moderate; shore fishes.
c. Air bladder simple; sides of body more or less convex; ventrals inserted anteriorly, far in advance of dorsal.....*Hyporhamphus*, 2.

2. HYPORHAMPHUS Gill.

Hyporhamphus GILL, Proc. Ac. Nat. Sci. Phila., 1859, p. 131, (*tricuspidatus*=*unifasciatus*).

Body elongate, moderately compressed, the sides of body not vertical, but more or less convex; the dorsal outline parallel with that of the belly. Upper jaw short; lower jaw prolonged into a slender beak, bordered with membrane; this beak shorter in the young; premaxillaries forming a triangular plate, the teeth of which fit against the toothed portion of the mandible; maxillaries joined to premaxillaries. Teeth feeble, mostly tricuspid. Gill rakers rather long. Head covered above with large, shield-like scales. Scales large, deciduous. No finlets; caudal fin more or less forked, the lower lobe the longer; dorsal and anal similar, opposite each other, not modified in the males; last ray of dorsal usually short; ventrals small, inserted well forward, nearly midway between opercle and base of caudal. Oviparous. Air bladder large, simple, not cellular. Young with the lower jaw short. Sides usually with a distinct silvery band, as in *Atherina*. Species numerous in all warm seas, going in large schools, but usually remaining near shore, feeding chiefly on green algæ. Size comparatively small.

(ὑπό, below; ῥάμφος, beak.)

a. Front of anal not behind front of dorsal.
b. Anal and dorsal opposite each other; scales 106.....*sajori*, 5.
bb. Anal slightly in advance of dorsal; scales 70.....*kurumeus*, 6.
aa. Front of anal under middle of dorsal.....*japonicus*, 7.

5. HYPORHAMPHUS SAJORI (Schlegel).

SAYORI.

Hemiramphus sajori SCHLEGEL, Fauna Japonica, Poiss., 1846, p. 246, pl. cx, fig. 2; Nagasaki.—BLEEKER, Verh. Bat. Gen., 1853, XXV; Japan, p. 116; Nagasaki.—GÜNTHER, Cat. Fish., VI, 1866, p. 265 (copied).—STEINDACHNER and DÖDERLEIN, Fische Japans, IV, 1887, p. 38; Tokyo.—ISHIKAWA, Prel. Cat., 1897, p. 18; Tokyo, Toshima.

Hemiramphus occipitalis GILL, Proc. Ac. Nat. Sci. Phila., 1859, p. 148; young specimen from Shimoda.

Head from tip of upper jaw $4\frac{3}{4}$ in length; depth 12. Dorsal 16; anal 17; scales 106. Eye 2 in postorbital part of head.

Body not much compressed. Mandible not extremely elongate, its length from posterior angle of mouth equal to distance from same point to base of pectoral. Upper jaw a little longer than wide. Gill rakers slender, the longest half the diameter of eye, 8+21 in number.

Top of head and tip of upper jaw scaled to tip, the scales more imbricated than in *H. kurumeus*. Sides of mandible with scales; 74 scales in a median row on back between dorsal fin and occiput.

Dorsal and anal opposite to each other and of about the same length; base of dorsal equal to distance from tip of upper jaw to posterior of eye. Ventrals inserted midway between anterior margin of eye and tips of median caudal rays. Length of pectoral equals postorbital part of head and half eye. Lower caudal lobe the longer, as long as base of dorsal. The middle rays not quite twice the diameter of eye.

Color in spirits: Brownish above, silvery below lateral stripe; scale pouches outlined with dark-brown dots on back. Sides of head silvery; mandible black; top of head and upper jaw dusky or black; lateral stripe distinct, widest under front of dorsal, outlined above by a dusky stripe. Dorsal and caudal dusky, other fins colorless.

Here described from a specimen 25 cm. in entire length from Aomori.

The young of this species agree very well with Dr. Gill's description of *H. occipitalis* (which was taken from a specimen 4 inches in length) except that his specimen is alleged to have fewer anal rays and 2 or 3 fewer dorsal rays. Owing to the small size of his type, a mistake of this sort might easily be made. No species other than *H. sajori* has been recognized along the coast of Hondo. Specimens were collected in salt water at Nagasaki, Matsushima, Aomori, Same, Tokyo, Misaki, Wakanoura, Kobe, and Hakata. It is one of the commonest fishes of Japan, much used for food.

(*sayori*, the vernacular name.)

6. HYPORHAMPHUS KURUMEUS Jordan and Starks, new species.

Head from tip of upper jaw 5 in length; depth 10 to 11. Dorsal 15 or 16; anal 17 or 18; scales 70.

Body not much compressed, the depth appearing greatest just behind opercles. Lower jaw from tip of upper half length of head; upper jaw slightly longer than wide. Teeth in upper jaw in a straight band at extreme sides, becoming broader anteriorly; those in lower jaw in a band narrower than the band at front of upper jaw and becoming narrower anteriorly. Eye equal to interorbital space, and contained twice in postorbital part of head. Gill rakers slender, scarcely as long as pupil, 7+19 in number.

Scales on top of head extending to snout. They are scarcely imbricated, circular, and with concentric striations, which form complete circles; similar scales on sides of mandible; from 47 to 50 scales in a median series on back between occiput and front of dorsal.

Pectoral rather slender and pointed, its length equal to eye and postorbital part of head. Anal beginning slightly in advance of dorsal. Base of dorsal equal to head from anterior edge of preorbital. The tip of the last dorsal ray when declined reaches to within a distance equal to the diameter of the eye of the base of the upper caudal rays. The ventrals are inserted midway between the base of the caudal rays and a point at the middle of opercle. The lower lobe of the caudal is the longer; its length equals that of pectoral, and is two-thirds the diameter of the eye longer than the upper lobe. The caudal is not deeply forked, the middle rays equal the postorbital part of the head.

No silvery pigment remains upon the body except along the lateral stripe, which is very conspicuous, much broader posteriorly than anteriorly, and bordered above by a dark line; back sparsely covered with small dark brown points, which sometimes outline the scale pouches; they usually arrange themselves in three lines medially along the back;

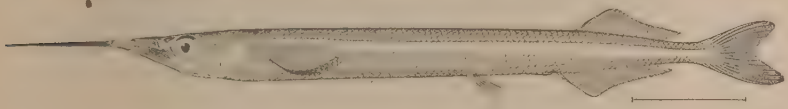

FIG. 1.—HYPORHAMPHUS KURUMEUS.

opercles bright silvery; top of head and upper jaw dusky, with black dots; a black blotch on mandible below maxillary; process of mandible jet black; fins all colorless except caudal, which is dusky.

This species differs from *H. intermedius* (as described by Dr. Günther) in having a slightly shorter anal, smaller eye, more anterior ventral, and pectoral not "blackish."

This is a fresh-water species. Numerous specimens were taken in the Chikugo River at Kurume, in the province of Chikugo, island of Kiusiu.

The type is 175 mm. in entire length and bears the number 7126 Ichthylogical collections, Leland Stanford Junior University Zoological Museum.

Dr. Ishikawa further records *Hyporhamphus dussumieri* (Cuvier and Valenciennes) from the Riukiu Islands. In this species of the Indian Ocean the dorsal and anal are nearly scaleless and the ventral midway between the head and the base of caudal. Sides with a silvery band. D. 15; A. 14. Scales 52.

7. HYPORHAMPHUS JAPONICUS (Brevoort.)

Hemirhamphus japonicus BREVOORT, Perry's Exp. Japan, 1856, p. 280; Loo Choo (Riukiu) known from a figure only.

Tip of lower jaw to edge of opercles 3 times in length from same point to center of margin of caudal. Tip of upper jaw to edge of opercles half of last, or 6 times in total length. Height of head or

body 9 times, and origin of dorsal to center of caudal a little less than one-fifth of length. Origin of anal to center of caudal 7 times and to origin of ventrals $3\frac{3}{4}$ in total length. Lower lobe of caudal $6\frac{1}{4}$ times in same distance; upper lobe one-third shorter and much narrower. Eye $2\frac{1}{2}$ in depth. Head and beak strong and stout. Body of equal height as far as ventrals. Pectorals pointed and equal to height of body in length. Ventrals with emarginate border, first and last ray of equal length. Dorsal with first ray nearly as long as height of body, with emarginate border, and last rays quite short. Anal beginning under middle of dorsal, and resembling it in form, but smaller. Caudal so deeply forked that it appears separated into two distinct lobes. Lower lobe longest and broadest, both pointed. Scales large, appearing to resemble those of *Hyporhamphus commersonii.*

Color bluish, darkest on back, lighter below. A tinge of green on sides and upper lobe of caudal. A narrow strip of green on middle of sides reaching from pectoral to caudal, with a broader stripe of pale silvery blue, tinged with greenish, bordering it on each side. Lower jaw dark indigo blue toward the tips, lighter toward the head. Fins all pale bluish, caudal dark dusky blue. Scales on back appear to have darker on their margins. (Brevoort.)

This species has not been seen since the drawing was made from which Brevoort compiled his description. His type was from Nafa, in the Riukiu Islands (Okinawa). The species is very doubtful and may not differ from *H. sajori.*

Family III. SCOMBRESOCIDÆ.

Body elongate, compressed, covered with small, thin, deciduous scales, the general aspect being that of a mackerel. Both jaws in the adult more or less prolonged, forming a slender beak, the upper jaw always the longer; teeth very feeble, pointed; maxillaries joined fast to premaxillaries, pectoral and ventrals small; dorsal and anal low, similar to each other, each with 4 to 6 detached finlets, as in the *Scombridæ;* gill rakers numerous, long and slender. Pharyngeal bones essentially as in *Exocœtus;* fourth upper pharyngeal on each side wanting or fused with the third; third pharyngeal greatly enlarged, separate from its fellow, covered with tricuspid teeth; second with simple teeth; first toothless; lower pharyngeals united, forming a triangular bone with concave surface, covered with tricuspid teeth; into the hollow of this bone the upper pharyngeals fit. Species few; pelagic fishes, swimming close to the surface in large schools in temperate regions. They bear strong analogical resemblances to the mackerels in form, color, and habits, as well as in the dorsal and anal finlets. The significance of this resemblance is unknown.

a. Jaws produced in a short beak, about half-length of rest of head.... *Cololabis*, 3.

3. COLOLABIS Gill.

Cololabis GILL, Proc. U. S. Nat. Mus., XVIII, 1895, p. 176.—JORDAN and EVERMAN, Fishes North and Middle Amer., I, 1896, p. 726 (*brevirostris.*)

This genus is close to *Scombresox*, differing chiefly in the very short beak, the upper jaw, even in the adult, not being at all produced, and the lower jaw having only a short flexible tip. This genus represents the immature state of *Scombresox*.

(κολός, defective, curtailed; λαβίς, forceps.)

8. COLOLABIS SAIRA (Brevoort).

SAMMA.

Scombresox saira BREVOORT, Perry's Exp. to Japan, 1856, p. 281, pl. VII, fig. 4 (on a drawing).—ISHIKAWA, Prel. Cat., 1897, p. 18; Tokyo.

Scombresox saurus NYSTROM, Svensk. Vet. Akad. Handl., 1887, p. 46; Nagasaki, not of Walbaum.

Head, including tip of lower jaw, $4\frac{1}{2}$ in length; depth $7\frac{3}{4}$. Dorsal 10 to 12—V or VI (rarely VI); anal 12 to 14—VI or VII; scales 120.

Body elongate and much compressed, the width of head $1\frac{1}{2}$ the diameter of eye. Eye placed exactly between tip of mandible and edge of opercle, its diameter contained $2\frac{1}{4}$ in snout. Teeth extremely small, in a single scattered row on edge of jaws, sometimes not evident. Maxillary produced to a sharp point; as viewed from above it is as long as broad. Mandible projecting to a short point, which enters upper profile when mouth is closed. Interorbital width equals diameter of eye, opercle and subopercle together forming a broad plate continuous on lower outline with that of the rest of head and ending behind in a blunt right angle. Gill rakers slender and numerous, as long as three-fifths the diameter of eye, 27 on lower part of arch. Gill slit not open above upper ray of pectoral. Top of head to tip of upper jaw with scales. One or two specimens show slight traces of large scales on opercles, cheeks, mandible, and preorbital. Usually, however, no trace remains, and in none of our numerous specimens are there any scales remaining in this region. Scales on body caducous, about 90 in a median row between occiput and dorsal. Pectoral short and broad, the lower rays growing rapidly shorter, its length twice diameter of eye. Ventrals inserted midway between base of caudal and middle of eye. Front of anal half the diameter of eye in advance of dorsal. Dorsal and anal finlets connected to body by an extremely thin delicate membrane which is usually broken and not evident, but through our large series it has been found with each finlet but the last.

Color in spirits abruptly silvery on lower half of body, above which is usually a bluish silvery lateral band nearly as wide as eye. Back

above lateral band abruptly slaty blue. Top of head to tip of upper jaw dark. Dorsal, caudal, and inner surface of pectoral dusky. Base of pectoral dusky. Other fins colorless.

Here described from numerous specimens 15 to 18 cm. in entire length, from Awa, obtained from Yonekichi Koneyama, a local naturalist.

Other specimens are from Otaru, Aomori, and Hakodate, the longest 29 cm. in length. It is locally known as Samma. The name *Saira* (*Sayori*) is used only for *Hyporhamphus*. Although not recognized by any author except Ishikawa since Brevoort, the species is common, running in large schools in sheltered bays from Tokyo northward. Nystrom's *Scombresox saurus* with shorter snout ("mendre ut dragen nos") is evidently *Cololabis saira*. The figure of Brevoort does not show correctly the number of finlets, which are 6 or 7, as in *Scombresox saurus*. The rare Californian species, *Cololabis brevirostris*, is close to *Cololabis saira*.

(*Saira* [*Sayori*], Japanese name of *Hyporhamphus*.)

Family IV. EXOCŒTIDÆ.

FLYING-FISHES.

Body oblong or elongate, covered with cycloid scales, which are rather deciduous. Lateral line running very low, along the sides of the belly. Head more or less scaly, with vertical sides. Mouth moderate, terminal, the jaws not prolonged into a long beak. Premaxillaries not protractile, hinged at base mesially; margin of the upper jaw chiefly formed by the premaxillaries; the short maxillaries entering the lateral margin; maxillary free from the premaxillary, its edge slipping under the front of the preorbital. Dentition various, the teeth small and weak. Dorsal fin without spines, inserted on the posterior part of the body, opposite the anal and more or less similar to it; ventrals abdominal, of several soft rays, inserted posteriorly; pectoral fin inserted high, used as an organ of flight; shoulder girdle and pectoral muscles very strong; caudal fin forked, the lower lobe the longer. No finlets. Vent close in front of anal. Nostrils large, double, near the eye. Lower pharyngeals enlarged and fully united, forming a large, transversely concave plate, covered with large, close-set, blunt, tricuspid teeth; third upper pharyngeal greatly enlarged, not united with its fellow, both covered with large, blunt, tricuspid teeth; fourth superior pharyngeal wanting in the adult (probably coossified with the third; vertebræ without zygapophyses. Gill membranes not united, free from the isthmus. Pseudobranchiæ hidden, glandular. Gill rakers various. Gills 4, a slit behind the fourth. Air bladder very large, not cellular, so far as known, and extending far backward among the hæmapophyses of the caudal vertebræ. Vertebræ

about 50. Intestinal canal simple, without cœca. Carnivorous or herbivorous. Abounding in all warm seas, mostly pelagic, swimming near the surface, and skipping or sailing through the air, sometimes for considerable distances.

a. Roof of mouth nearly toothless; pectoral and ventral fins very long, both used as organs of flight.

b. Anal fin long, its base about equal to that of dorsal, its rays 11 or 12. *Exonautes*, 4.

bb. Anal fin short, notably shorter than dorsal, its rays 9 or 10..... *Cypsilurus*, 5.

4. EXONAUTES Jordan and Evermann.

Exonautes JORDAN and EVERMANN, Check List Fishes N. Amer., 1896, p. 322, (*exsiliens.*)

This genus includes those flying fishes having both pectoral and ventral elongate and the anal fin about as long as the dorsal fin, of 11 or 12 rays.

Species numerous, smaller in size than those of *Cypselurus*, although larger than those of *Exocœtus* proper.

(ἔξω, out of; ναύτης, swimmer.)

9. EXONAUTES BRACHYCEPHALUS (Günther).

Exocœtus brachycephalus GÜNTHER, Cat. Fish., VI, 1866, p. 297; China.—LÜTKEN, Vid. Med. Nat. Foren, 1876, pp. 110, 405.

Head, 4½ in length; depth, 6½. Dorsal, 11; anal, 12; scales, 49. Eye, 3⅞ in head.

Snout short, 1⅓ in diameter of eye; interorbital space broad, its width a little greater than diameter of eye; supraorbital region pro-

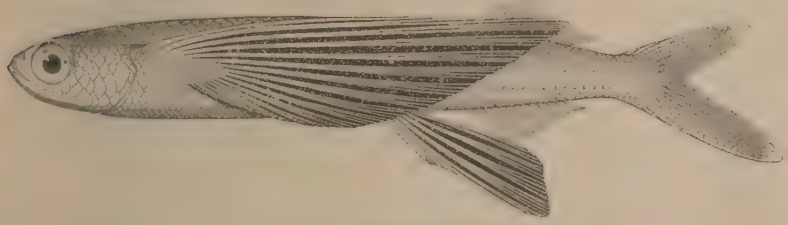

FIG. 2.—EXONAUTES BRACHYCEPHALUS.

truding on each side, making interorbital concave; maxillary reaching to just below anterior margin of eye. Thirty-four scales on a median line of back before dorsal. Lateral line forming a more than usually conspicuous ridge along lower sides of belly. Pectoral reaching to tip of declined anal ray; its first ray contained 2¼ times in entire fin and exceeding the head in length by a distance equal to the diameter of the eye. The outer half of the divided second ray fails to reach the tip of the third or largest ray by a distance equal to eye and snout; the inner half extends nearly to the tip of the third. Ventrals inserted

midway between the base of the caudal and the posterior margin of the eye; they reach slightly past the tips of the pectorals. The inner part of the second ray and the outer part of the third protrude beyond the tips of the other rays and form a sharp angle. The outer rays of the ventrals are not graduated. The first or outer ray is scarcely over a third as long as the longest part of the second.

Color in spirits a clear light brown above, silvery below. The membrane of the pectoral is dark brownish, without spots or markings. The rays on the outer side are silvery, making the fin appear silvery when closed. Ventrals brown like pectorals, with the inner and outer ray very light. Anal colorless and dorsal colorless, except for a small dark brown spot at tips of fifth and sixth rays. Caudal dusky.

Here described from a small specimen from Misaki, presented by the Imperial University of Tokyo. It is 13 cm. in length. It is probably rare in Japan, drifting northward in the warm current, or Kuro Shiwo. It was originally described from China. It has been identified, probably incorrectly, with the European species, *Exonautes rondeleti.*

(βραχύς, short; κεφαλή, head.)

5. CYPSILURUS Swainson.

Cypsilurus SWAINSON, Classification Fishes, etc., II, 1839, p. 296 (*nuttalli*, based on young with barbels).

Body elongate, broad above, somewhat compressed. Head short, blunt, narrowed below. Mouth small. Jaws very short, about equal. Chin without barbel in the adult, often with one or two long fragile barbels in the young. Maxillaries not joined to the premaxillaries. Teeth very feeble or wanting. Eyes large. Gill-rakers moderate. Scales large, deciduous. No finlets. Dorsal fin short, opposite anal, which is shorter than dorsal, of nine or ten rays. Caudal widely forked, the lower lobe the longer. Pectoral fins very long, reaching past the beginning of the anal, and serving as organs of flight, their great size enabling the fish to sustain themselves in the air for some time. Ventral fins large, posteriorly inserted, also used as organs of flight. Air bladder very large. No pyloric cæca. Species numerous in all warm seas, living mostly in the open water and swimming in great schools. The species are largely cosmopolitan and are the largest of the flying fishes.

(κύψελος, swallow; σύρά, tail.)

a. Second pectoral ray divided.
  b. Ventrals pale or slightly dusky.
    c. Pectoral fins unspotted, reaching nearly to end of dorsal: D. 13. A. 9; scales, 52 ..... *agoo*, 10.
    cc. Pectoral fins spotted with black; anal pale; scales, 42 ..... *pœcilopterus*, 11.
  bb. Ventrals mostly jet black; anal black posteriorly; fins all dark: D. 12. A. 9. *hirundo*, 12.

10. CYPSILURUS AGOO (Schlegel).

TOBI-NO-UWO (FISH OF FLIGHT:) TOBISUWO (FLYING-FISH): AGU.

Exocœtus agoo SCHLEGEL, Fauna Japonica, Poiss., 1846, p. 247; Nagasaki, from a drawing.—ISHIKAWA, Prel. Cat., 1897, p. 18; Tokyo.

Cypsilurus agoo JORDAN and SNYDER, Check List Fishes of Japan, 1901, p. 60; Yokohama.

Exocœtus döderleini STEINDACHNER, Fische Japans, IV, 1887, p. 38; Tokyo.

Cypsilurus döderleini JORDAN and SNYDER, Check List, 1901, p. 60; Yokohama.

Head, $4\frac{1}{2}$ in length; depth, $5\frac{3}{4}$ to $6\frac{1}{2}$. Dorsal, 13 or 14; anal, 8 or 9; scales, 52; eye, $3\frac{1}{4}$ to $3\frac{1}{2}$ in head.

The depth of head and body is very variable; in some specimens the opercle is broadly rounded; in others it slants upward and backward more obliquely and has a slight flap. Between these extremes there are all intermediate conditions.

The pectoral reaches in the shortest examples nearly or quite to the base of the last dorsal ray; in the longest to the tips of the last declined dorsal ray. The simple upper ray is contained about $1\frac{3}{4}$ times in the length of the entire fin. The second ray is branched, its

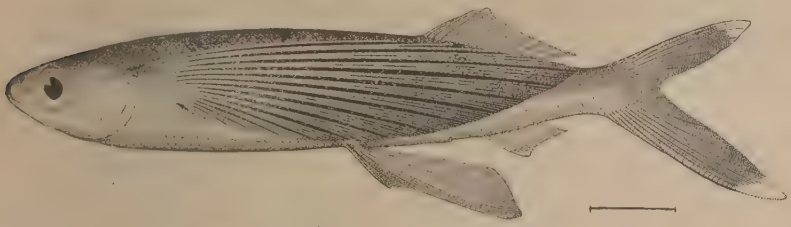

FIG. 3.—CYPSILURUS AGOO.

lower branch the longer, and reaches to within from 1 to 2 times the diameter of the eye to the tip of the third or longest ray. The succeeding rays rapidly and uniformly diminish in length to the ninth ray, and thence more rapidly to the last.

The ventrals reach from slightly beyond the middle to the end of the anal base. The base of the dorsal is contained from $1\frac{1}{5}$ to $1\frac{1}{4}$ in head; that of the anal, $2\frac{1}{2}$ to $2\frac{3}{5}$.

Color in spirits slaty brown on back, shading to silvery on lower parts of head and body; when scales are lost, as in most of our specimens, the color is bluer and the edges of the scale pouches are conspicuously dark. The maxillary is dusky; a dark band is on eye around and above upper part of iris. The ventrals are white on lower surface, on upper either white or slightly dusky along the outer rays; nearly always the base of the first ray is dusky. In the closed pectoral the upper rays to their tips appear lighter than the median rays, which grow gradually darker to black toward their tips. The membrane is bluish black, fading out below and colorless between lower rays. Color in life metallic bluish above.

The above description is taken from specimens 10 to 12 inches long from Nagasaki.

Numerous specimens were collected at Tsuruga, Nagasaki, Tokyo, Myiako (north of Sendai), Hiroshima, Hakata, Onomichi, and Aomori.

It is the common flying-fish or Tobis-Uwo of Japan, abundant all along the coast in the summer. It is subject to a number of variations, but all specimens examined by us seem to belong to one species. *Exocœtus döderleini* is evidently identical with *Cypsilurus agoo*.

(*agu*, a vernacular name, now rarely used.)

11. CYPSILURUS PŒCILOPTERUS (Cuvier and Valenciennes).

Exocœtus pœcilopterus CUVIER and VALENCIENNES, Hist. Poiss., XIX, p. 112, pl. DCXI; New Britain.—GÜNTHER, Cat. Fish., VI, 1866, p. 291; Formosa.
Exocœtus, sp. No. 309, ISHIKAWA, Prel. Cat., 1897, p. 18; Hakodate.

A specimen in the Imperial Museum at Tokyo is probably referable to the above species. The following notes were taken on this specimen:

Scales 42, 24 before dorsal; anal short; head flattish above; body rather plump; pectoral reaching to middle of dorsal, its second ray divided; dorsal low; ventrals reaching past front of anal.

Color: Ventrals dusky behind, perhaps faded; dorsal unspotted; pectorals profusely and coarsely spotted with black, the spots unequal. According to Günther the dorsal has 12 or 13 rays, the anal 9, the distance from first dorsal ray to first of caudal being much greater than length of head.

Described from a stuffed specimen, 10 inches in length, taken at Hakodate. It is questionable whether this species is really identical with *C. pœcilopterus*, but no other described species agrees as well.

(ποικιλός, variegated; πτερόν, fin.)

12. CYPSILURUS HIRUNDO (Steindachner.)

Exocœtus hirundo STEINDACHNER, Ichthyol. Mittheil., VIII, 1866, p. 482, pl. IV, fig. 2; Hongkong.

Head $4\frac{1}{2}$ in length; depth $6\frac{3}{4}$. Dorsal 12; anal 9; scales about 53.

Body not compressed, about as wide as deep, the head short, widest at a level with upper edge of pupil; its width equal to distance from edge of opercle to middle of eye. Eye two-fifths longer than snout, contained $1\frac{1}{6}$ times in postorbital part of head. Lower jaw projecting, the tip injured in our specimen and the barbels missing. The interorbital space is wide and shallowly concave, its width a little greater than the diameter of the eye. Snout short and broad at the anterior margin of the eyes; its width is three-fifths of its length.

The pectoral reaches to under the seventh or eighth dorsal ray. Its upper ray is undivided and is contained $2\frac{3}{4}$ times in the length of head

and body. Its second ray is divided, the under ray the longer, reaching to within a diameter of the eye of the tip of the third or longest ray. The ventrals reach to the base of the lower caudal rays. Their base is midway between their tips and the edge of the opercle; three or four of its outer rays grow gradually shorter; the outer one is twice the diameter of the eye in length.

Color in spirits light brown on back, abruptly silvery on head and body below the level of middle of eye. The maxillary is dusky and the suborbital and opercular regions are dusky with points of brown over the silver. The pectoral is jet black, changing to white on the lower rays. The ventrals are colored like the pectoral and with lighter inner rays. The dorsal is dusky toward the ends of the rays. The posterior fourth of the anal is abruptly black. The caudal has two dusky spots, which appear in Dr. Steindachner's plate of this species as the interspaces between two white spots. The caudal peduncle is dusky above.

This description is taken from a specimen 10 cm. in length from Wakanoura.

A small specimen, 35 mm. in length, differs in having the pectoral reaching only to below the third dorsal ray. At the symphysis is a wide, flat, triangular barbel, which is very slightly trifid at its lower margin.

This species is apparently identical with *Exocœtus hirundo* described and figured from Hongkong. It is not yet recorded from elsewhere. (*hirundo*, swallow.)

SUMMARY.

Suborder SYNENTOGNATHI.

Family I. BELONIDÆ.

1. *Tylosurus* Cocco.

1. *schismatorhynchus* (Bleeker); Nagasaki, Wakanoura.
2. *giganteus* (Schlegel); Nagasaki, Wakanoura.
3. *coromandelicus* (Van Hasselt); Tsuruga, Yokohama.
4. *anastomella* (Cuvier and Valenciennes); Yokohama, Tokyo, Matsushima Bay, Hakodate.

Family II. HEMIRAMPHIDÆ.

2. *Hyporhamphus* Gill.

5. *sajori* (Schlegel); Aomori, Matsushima, Tokyo, Misaki, Wakanoura, Kobe, Hakata, Nagasaki.
6. *kurumeus* Jordan and Starks; Chikugo River at Kurume.
7. *japonicus* (Brevoort).

Family III. SCOMBRESOCIDÆ.

3. *Cololabis* Gill.

8. *saira* (Brevoort); Awa, Aomori, Hakodate, Otaru.

Family IV. EXOCŒTIDÆ.

4. *Exonautes* Jordan and Evermann.

9. *brachycephalus* (Günther); Misaki.

5. *Cypsilurus* Swainson.

10. *agoo* (Schlegel); Aomori, Tokyo, Miyako in Rikuzchu, Tsuruga, Nagasaki, Hiroshima, Onomichi, Hakata.
11. *pœcilopterus* (Cuvier and Valenciennes); Hakodate.
12. *hirundo* (Steindachner); Wakanoura.